UNIVERSITY OF CALIFORNIA.

AGRICULTURAL EXPERIMENT STATION.

BULLETIN NO. 19.

[In order to render the results of investigations and experiments conducted by the Agricultural Department of the University of California more quickly and more generally available than has heretofore been done through the annual or biennial reports, it is proposed to embody hereafter, in the form of "Bulletins," to be issued as often as may seem desirable, reports of results, as well as such other discussions, information or answers to questions as may be of general interest. It is intended to make these bulletins, as a rule, short enough for insertion in the daily or weekly papers of the State, and proof-slips of the same will be regularly mailed to papers applying therefor. The substance of these bulletins will ultimately be embodied in a more complete and connected form, in the annual reports of the College of Agriculture.]

[When, a few years ago, the vineyard plot on the University grounds passed into the charge of the College of Agriculture, it was soon discovered that it was strongly infested with the Phylloxera. It was at first intended to extirpate the pest as quickly as possible; but when it became obvious that the law intended to prevent the further spread from infested districts could and would not be enforced, the fact that there are no vineyards so situated as to be liable to infection through natural causes from this locality, while it offers an excellent opportunity for the systematic observation of the habits of the insect in this climate, and for experiments with remedies and resistant vines, caused the idea of the immediate extirpation to be abandoned in favor of the experimental use of the plot. It is hardly necessary to say that ever since, a rigorous system of disinfection has obviated all danger of the accidental transmission of the insect to uninfected districts. The summary report of Mr. Morse, given below, shows the results of this season's observations. —E. W. HILGARD.]

Observations on the Phylloxera made during 1884.

It has been supposed heretofore that only a part of the recognized forms of the phylloxera exists in California. This apparent divergence from the natural habits of the insect has given direction to the investigations which have been carried on at the University.

A partial report on the forms found in our own vineyard plot was published in the report of the Agricultural Department for 1882, and may here be briefly summarized. It shows that the larvæ, and a small proportion of the wingless mother insects, pass the winter in a dull, lifeless condition, but are easily brought to life and activity by a proper change in temperature; that the middle of April finds the adult mother beginning to lay; and that soon after young larvæ are produced and scattered to all parts of the roots. The increase is slow until about the middle of June. Shortly after, the larval form with rudimentary wings appears, and by the first of July the winged form is found fully developed. The eggs of the mother louse are most abundant at the end of the same month, and at the same time a decrease in the numbers of adult mothers becomes apparent; the maximum number of larvæ is also reached. Only a few eggs are usually found after October, and very little action is noticeable after November. The time of these changes, however, will vary greatly with the season.

In the laboratory it was found that a single insect produced 75 eggs, laid frequently at the rate of 5 per day; some days none at all were produced. Thirteen days are required to hatch them, and 17 more for the development into egg-laying mothers.

The object of investigation since the above was published has been toward determining the existence, habits and movements of less familiar forms.

The late rains this summer have stimulated a generous growth of those finer roots on which the winged-form is produced in greatest abundance. Around such roots were placed properly arranged "traps," viz.: glass jars or bottles, partially buried in the soil. A rapid production of the winged form was noted from the 20th of August to the beginning of September; some were developed as late as October 10th. As many as five eggs were laid by some of the confined winged insects, before death; none of these eggs, however, were observed to hatch, hence no sexual individuals were obtained.

In arranging the glass-jar "traps" the soil was considerably loosened up, and thus was prepared the way for the migration of the winged insects, which occurred about the 20th of August, when they could be found in considerable numbers crawling about upon the small lumps of earth, preparatory to taking wing. Only one was actually seen to fly up to the vine, although others were found quietly fixed upon the under side of some of the leaves. This passing through the loosened earth, and later through the unmolested soil, continued up to the present time.

The insect in various stages of development could be found in the earth from the surface to the roots, the most incomplete forms being found deepest below the surface of the ground. Some were found under stones, and in such positions as to place it beyond a doubt that they passed through the changes underground, and came to the surface in a transformed condition, contrary to the accepted belief of a transformation at the surface of the ground.

A peculiar circumstance was noticed on the 20th of August, in the appearance of a large

number of larvæ upon the surface of the ground. They were found as much as two feet from the stock, and from 3 to 12 inches from the fine roots, as well as through the soil to the roots. The significance of their appearing in this manner can be appreciated when we learn that they crawl upon bits of rubbish, sticks, leaves, etc., upon the spot, and even take kindly to growing canes placed in their way.

Up to August 26th no specimens of the gall-louse, or leaf-inhabiting form of the Phylloxera, had been identified at the University or elsewhere in California, so far as known. At this time the fresh young leaves near the ends of three canes, which stretch from a "Canada" vine toward the infected stock, bore a few peculiarly formed galls, containing egg-laying mother-lice as well as eggs, and numerous larvæ. A few isolated and abandoned ones were also found on the old leaves nearer the stock of the vine. It thus seemed probable that the root-inhabiting form had here changed its habit toward that of the gall louse, a point still held in dispute by the French scientists.

An attempt was therefore made to produce more galls upon the foliage of the "Canada" vine by infecting it with larvæ from the roots of the adjoining infested stock. A cane was led from the opposite side of the resistant vine, and its terminal leaves fastened to an infested spot of soil. The leaves and part of the canes were soon covered with young larvæ, and a few quiet winged insects; the former passing freely about upon the leaves but forming no galls or at least, only doubtful and abortive attempts. Some of the young leaves upon the infected canes were pierced by young larvæ which had settled just outside of the fresh galls, and had remained until a red dead spot had been formed. Others of the larvæ were seen crawling about; but they did not readily establish galls. Contrary to the usual habit of the gall louse, they kept mostly upon the *under* side of the leaf.—It thus appears that at least so late in the season, the change of habit from root to leaf is not readily made.

Of the known *enemies to the Phylloxera*, only two forms were identified during our observations. The *Phylloxera thrips* were seen passing about in considerable numbers upon the leaves and some even came from the galls, many of which they had cleared of their inhabitants. A few specimens of the *Tyroglyphus*, or *Phylloxera mite* appeared among the winged insects that were taken from the "trap;" they were also found upon the roots of adjoining vines. It is, therefore, probable that its usual enemies have accompanied the Phylloxera to California.

Several practically important conclusions result from the above observations. It appears that the light summer rains of the season have favored to an extraordinary degree the development and activity of the pest, especially of its winged form, most dangerous as the carrier of infection; and that this form was developed through the months of July, August and September, and a part of October, while the numbers and activity of the larvæ in ascending through and diffusing themselves over the soil, was greatest toward the end of August. Any measures to prevent the spread of the insect during the season should, therefore, be taken prior to August, at least.

It is also shown how readily the young insects will ascend through the soil from superficial rootlets, and will attach themselves to any object lying in their way, so that infection may be carried readily from one vineyard to another by the mere passage of a wagon, plow, or other implement, as well as through fruit boxes, prunings and cuttings. Especially are the eggs of the winged form liable to be thus carried, even by gusts of wind taking up leaves, etc. The gall-louse form, now also recognized here, adds danger to this vehicle.

Finally it is clearly shown that in ordinary soils no preventive used only *around the stock of the vine* can offer security against the ascent of either the winged or wingless form to the surface from outlying shallow rootlets, from which they can freely migrate to other uninfected stocks; and that, therefore, the utmost care alone can check the progress of the pest after it has once gained a footing. F. W. MORSE.

Berkeley, Oct. 10, 1884.